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Investigating the Properties of Cement Concrete Containing M-Sand as Fine Aggregate for M30 Grade Concrete

Ankit Pandey[1], Afzal Khan[2]

[1]Student, [2]Assistant Professor,

[1,2]Department of Civil Engineering, Millennium Institute of Technology & Science, Bhopal, Madhya Pradesh, India

ABSTRACT

M-sand also called artificial sand or crushed sand, the prepared by crushing rocks, stones, or larger aggregates into small size particles in the quarry. The study is aimed at the complete replacement of conventional material like river sand used as fine aggregate. By using M-sand (manufactured sand/crushed sand). M-sand here acts as a fine aggregate in the cement concrete. The experiment is carried out by finding the value of slump, compressive strength, and split tensile strength. Natural fine aggregate is replaced by M-sand to complete mix proportion in the concrete. M-sand shares similar properties as conventional Fine Aggregates and gives good split tensile and compressive strength to the concrete. The results are compared with the control mix of design mix M30. The specimens are tested after 7 days and 28 days of curing. Complete replacement of fine aggregate with manufactured sand concrete makes the cost of construction can be controlled. Strength, workability, and durability test also studied. Compressive strength is the most important property of concrete it is also increasing. Complete replacement of fine aggregate with crushed sand production of concrete increasing. It is dust-free in M-sand which is a good sign to do the replacement. Environment preservation and natural resources conservation is the soul of country development.

The application of crushed sand mix for residential building structural members such as column, beam, slab, and foundation and plastering are also elicited. The study brings out the fact that it is also more economical than the typical cement concrete.

The findings of this research call for the safe use of manufactured sand. Economical concrete mix is a very useful material for construction, which offers a range of economic, technical, and environmental enhancing and preserving advantages and is destined to become a dominant material for construction in the new era. With increasing structure construction work, its availability and less transportation cost also an important factor as an alternative for river sand.

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KEYWORDS: *Compressive strength, split tensile strength, Workability, M-sand, fine aggregate, water, concrete, strength*

1. INTRODUCTION

1.1. General

The demand for concrete goes up tremendously day by day. It is a highly used construction material now a day in the world. It is one of the basic requirements for the creation of any infrastructure, buildings, roads, etc. Natural or River sand are weathered and worn-out particles of rocks and are of various grades or sizes depending upon the amount of wearing. When fine particles are in proper proportion, the sand will have fewer voids. The cement quantity required will be less. Such sand will be more economical. Concrete requires natural aggregates, which are obtained from quarries. The fine aggregates generally used is the river sand. Such deposits do not require much processing other than size grading. Most of the tropical and subtropical countries still depend upon river sand for fine aggregates. But now it is well

understood that indiscriminate sand mining causes irreparable and irreversible damages to the ecological system. Both coarse and fine aggregates are natural resources, once used cannot be replenished. Sand mining causes many problems to flora and fauna also. Excessive sand mining causes unpredicted water course causing floods in surrounding areas, water pollution, etc.

If there will be the complete replacement of fine aggregate with M-Sand then there will be carbon dioxide level reduced in the environment, generated at a time of sand mining and transportation.

M-sand is the product obtained from hard granite stone by crushing. The Crushed sand is of cubical shape with grounded edges, washed and graded. The size of manufactured sand is less than 4.75mm.

A study carried out by The United Nations Environment Programme (UNEP) released a report, "Sand and Sustainability: Finding new solutions for environmental governance of global sand resources", that highlights a problem that has largely stayed under the radar: sand consumption globally has been increasing and we are extracting it at rates exceeding natural replenishment rates. So, there is a need to look for an alternative material for fine and coarse aggregates such as crushed stone, mine waste, and other industrial waste products. Presently, that can be used as **complete replacement for fine** or coarse aggregates. But many of the times, it is neglected as an alternative even though they are available huge in quantity in terms of millions of cu.m.

The rising growth of population and economy in India is leading to industrialization. Urbanization is prominent in various kinds of researches in the engineering fields over recent years. While some of these alternatives push forward the efficiency rate, some of them ease the demand for traditional raw materials. For instance, in frame structures, walls act as screens to maintain a room's privacy. These walls support self-weight, and for that masonry components of low density and low strength materials can be used, which can help in reducing the dead load of the structure effectively. Since most of the concrete mixture is expended in the walls, a component of the mixture can be considered to be substituted in a manner that did not compromise the performance of the mixture. Growing the population of the country requires more creation of the settlement. Thus, new techniques and different materials should be constructed of new buildings. Furthermore, a number of the settlement haven of those buildings against natural disaster is the durability of the construction and also thermal conductivity. The use of M-sand in concrete production is good as a point of environmental and financial condition. The result of the study has shown that M-sand has unique properties and is good for comparison to other materials of the building.

2. Problem Identification and Objectives

2.1. Problem Identification

The concrete is formed by different materials are mixing such as cement, fine aggregate, and coarse aggregate, and water. It produces a material that can be converted to any shape. Maximum parts of concrete are filled with fine aggregate. Fine aggregate has reduced the shrinkage of concrete and increases the other properties of concrete. Fine aggregate is not economic for transport and in some cases it is not good for the environmental and social impacts so we can find out local available and cheap resources without affecting the natural resources of minerals. In this work, we can find out the benefit of partial replacement, and in some cases, complete replacement of fine aggregate with manufactured sand of different percentage ratios are to be used. Physical properties and chemical properties are needed to be investigating to ensure the suitability of the other material used in cement concrete mix. Which is Portland Pozzolana Cement can mix together with the manufactured sand as in place of natural river sand to produce the same result compared to normal river sand fine aggregate.

2.2. Objective of the study

The objectives of the study are given below: -

1. The main objective of the study to evaluate the potential of m-sand to be used as a complete substitution of natural sand in concrete. With PPC and coarse aggregate with grade M30.
2. Manufactured sand in ratio of 0, 50, and 100% replacement used as a fine aggregate to record the result of different percentages and observe to find efficiency. That can be used of MS with complete replacement of fine aggregate to the desired result.
3. To compare the compressive strength, split tensile strength of mixing MS as a complete replacement of natural sand with control concrete mix.
4. Also, we find out workability, compressive strength, and tensile strength at different % and in the concrete preparation of 7 and 28 Days using cubic moulds, cylinders and beam have to find out the peak % of MS.
5. It can be replaced by a conventional concrete mix.
6. Compare with control concrete and conventional concrete and finally analyze it can be used for construction industries as a full-time alternate material as a mix proportion of fine aggregate.

3. METHODOLOGY
The materials were utilized as a part of the test program, material required for the study are natural coarse aggregate, fine aggregate, saw dust and water are used.

3.1. Cement
Cement is the main material in concrete production. It was developed from natural cement in the early nineteenth century in Britain and its name was derived from "Portland stone", a type of stone that can be originated in the Isle of Portland in England. At the present time, cement becomes essential in every construction works to use in structures such as buildings, tunnels, bridges, and others.

Cement is a finely crushed, dry material that by itself is not a binder. In presence of water and cement minerals, the chemical reaction known as the hydration process will take place. Cement usually acts like glue because its properties bind aggregate which is sand and gravel together. So many types of cement used in construction work it is a binder material, the property of cement it should be hardened and adheres to other materials to bind them together easily. PPC produced less heat of hydration and more resistance of water than OPC. Different characteristics of cement depend upon chemical composition. PPC Cement used in this project brand name mycem Cement shown in fig.2. The use of admixture, changing the chemical composition, and use of different raw materials have resulted in the availability of many types of cement.

Pozzolana is a natural or artificial material it containing silica in a reactive form. The cement used in this experimental work is Portland Pozzolana Cement (PPC) conforming to the code IS: 3812:1981.

3.1.1. Testing of Cement
The following tests are done on the cement:
A. Fineness test
B. Specific gravity test
C. Soundness test
D. Initial and final setting time test.

A. Fineness Test-
Object- To determine the cement particles size more than 90 μm. Using fineness test of cement.

Apparatus required-
- 100gm cement
- Weigh machine
- IS Sieve 90micron meter

Figure: 3.1 Sieve sample Procedure

Procedure:
- Take a sample of cement and scrub the cement with hands.
- The test sample should be free of pieces.
- Take 100gm of cement, W1.
- Take cement 100gm in sieve and close of sieve with cover.
- Then, shaking the sieve by both and up to 15 minute.
- After shaking retained cement take weigh note W2.
- Finally find out the total weight of percentage of retained cement on sieve.

Take different cement sample and above process with three time and find out average value to get accurate result.

% Of cement retained in sieve = (W2/W1) *100

B. Specific Gravity Test-
Object - To determine the specific gravity of cement

Apparatus Required
- Portland Pozzolana Cement sample
- Kerosene oil
- Pycnometer (100 ml)
- Weighing machine with 0.1 gm accuracy.

Procedure-
- To calculate sp.gravity of cement bottle should be dry.
- Weight the empty bottle (w1).
- Then cement sample are fill in the half part of bottle and take weigh (w2)
- After, in cement bottle fill kerosene oil full surface of the bottle.

- Mixing properly of bottle shaking to remove air bobble those are present in the bottle.
- Then, take weigh the cement and oil fill in bottle (w3).
- Remove in the bottle cement and oil,
- Finally bottle filled only kerosene oil up to top surface of bottle and weigh (w4).

Specific Gravity,
Sg = [(w2-w1)] / [(w2-w1)-(w3-w4)*0.79]

Where, 0.79 is sp.gravity of kerosene.

C. Initial and Final Setting Time of Cement Test-
Object - To determine the initial and final setting time of cement.

Apparatus Required
- Cement
- Weigh machine
- Glass plate
- Stop watch
- measuring cylinder
- Tray
- Travel

Procedure-
- Take cement sample 400gm and make paste of cement and 0.85p water by weigh of cement.
- Time of scale keep 5 min. than using stop watch added water in cement and record the time(t1).
- Then mould are totally filled with cement paste and finish the surface by trovel.

Initial Setting Time test
1. Firstly, paste is replaced in the mould and resting on the solid surface bearing the needle.
2. Then, needle is slowly to lower down and comes to the contact of surface of the paste and firstly remove and it to be permit for penetrate.
3. In Starting needle are remove within 2 minutes till the needle failure show up to 5 mm. it measuring from lower of the mould. And noted time (t2).

Final Setting Time
1. To find out final setting time of cement, needle is replacing vicat apparatus by needle with an attachment.
2. Cement is finally set when using final setting needle slowly to surface of test sample.
3. Then take its time (t3).

Calculations
Initial setting time= t2-t1

Final setting time= t3-t1

Where,
Time taken when water are added in first time = t1

Time taken when, needle fails to penetrate 5 mm from lower surface of the mould= t2

Time taken when, needle impressed but its fail to the attachment = t3.

The physical and chemical property of cement according to IS 1489-1991. And conducting so many tests after result given below in the table 3.1.

Table 3.1 Physical Properties of Portland Pozzolana Cement

S. NO.	Particulars	Requirement
1.	Fineness obtained (in m2/Kg)	300 (min)
2.	Setting time (Minutes)	
	i. Initial	35
	ii. Final	600 (max)
3.	Soundness	
	i. Le-chattlier expansion (In mm)	10 (max)
	ii. Autoclave (%)	0.8 (max)
4.	Specific Gravity	2.85

Table 3.2 Chemical properties of PPC

S. No.	Particulars	Requirement
1.	Mgo% by mass (max.)	6.10
2.	SO2 % by mass (max.)	3.10
3.	Loss of ignition by % mass (max.)	5.10

3.2. Aggregates
Aggregates are the very important constituents in concrete. In concrete vary important materials of aggregate just because 72-82% of aggregate are used in concrete for total volume. Generally aggregate are categorized into two categories according to its size - coarse aggregate and fine aggregate.

3.2.1. Coarse Aggregate
It is defined on the basis of size which is 10mm and 20 mm. generally used in construction purpose 12.5 mm passing and 10 mm retaining sieve aggregate are used. So many tests are conducted to find out properties of coarse aggregate and analyzing according to IS code 383- 1970.

3.2.1.1. Tests of Coarse Aggregate
The following tests are conducted to know the properties of Coarse Aggregate:

A. Specific Gravity test and Water Absorption test.
B. Aggregate Crushing value test.
C. Aggregate Impact value test.
D. Aggregate Abrasion value test.
E. Aggregate Shape test.

A. Sp.Gravity and Water Absorption Test-

Object- To determine the Sp.Gravity test and water absorption test of aggregate by pycnometer method.

Apparatus required-
- Weigh machine capacity not ne less than 5kg, with accuracy 0.5 kg.
- Oven temp.105 to 110 degree Celsius.
- Pycnometer with 1 liter capacity. 6mm ole to its upper surface and its water tight.
- supplying current warm air.
- Area of tray 32cm2.
- Sample is taken in air tight container.
- Funnel and filter paper.

Procedure-
1. Take coarse aggregate 500gm with dry condition.
2. Take empty condition pycnometer weigh.
3. Then, coarse aggregate are filled in pycnometer.
4. Pycnometer filled with water up to top surface.
5. Removing the air bubble by hand shaking of pycnometer.
6. Outer surface of pycnometer are wiped by cloth and weigh (w).
7. Then, coarse aggregate and water are transfer into a tray.
8. Filled pycnometer only distilled water to the top surface of pycnometer.
9. Take weigh (w1).
10. Using filter paper drain out the sample.
11. Moisture aggregate kept in oven with temp. 105 to 110 degree Celsius. For 24 hours.
12. After, removing the sample from oven and cooled in room temp and take weight (w2).

Apparent sp. gravity = (weigh of dry sample/weigh of equal vol. of water)

= w2/(w2-(w-w2))

B. Aggregate Crushing Value Test

Object-To determines the crushing strength value of aggregate.

Apparatus required-
- Aggregate sample
- IS Sieves (12.5mm, 10mm)
- Cylindrical metal measure
- Tamping Rod
- Weigh machine (10kg)
- Oven (3000 degree Celsius)
- Compression testing Machine (2000KN)
- Steel cylinder

Sample preparation-

Coarse aggregate passing 12.5mm size sieve and retaining 10mm sieve. before testing aggregate are placed in oven for removing moisture up to 4 hrs**.**

Procedure-
1. A steel cylinder is completely filled with dry aggregate with three equal layer and each layer give 25 no. of bellows using temping rod. And finished the surface by trowel.
2. Take weigh the steel cylinder (wa).
3. Then, steel cup is placed in compression testing machine and place aggregate in three equal layer and each layer 25 no. of bellows using temping rod.
4. Finished the surface by trowel.
5. Starting the machine given loading 40 tons load up to 10 minute gradually
6. Then, aggregate is removed from the cup and sieved by 2.36mm sieve.
7. Material passing 2.36 mm sieve take weigh (wb).

Aggregate crushing Value = (wb/wa) *100

C. Impact Value Test of Aggregate

Object- To determine the toughness of aggregate using impact value test.

Apparatus Required-
- Testing machine
- Sieves
- Measuring cylinder
- Tamping Rod
- Weigh machine
- Oven (3000degree Celsius)

Test preparation-

Aggregate passing 12.5 mm sieve and retaining 10mm sieve. Before testing aggregate are dry in 4 hours in oven temperature 105 -110 degree Celsius.

Procedure-
1. Take aggregate sample and filled in mould three equal layer and each layer given 25 no. of blows.
2. Steel cup fixed in machine and mould replaced in cups either 25 blows using temping rod.
3. Hammer is raised up to 38 cm from base and allow free fall up to 15 times.
4. In this process after removing cup from machine and take crushed material sieve using 2.36 mm sieve. 5. Take weight material passing sieve 2.36. Aggregate impact Value = (wb/wa) *100

D. Aggregate Abrasion Value Test

Object - To determine the hardness of aggregate by los angeles apparatus.

Apparatus Required-
- los angels testing machine
- 445gm weight and 48mm dia. steel balls.
- IS sieves
- weigh machine
- Oven
- Tray.

Procedure-
1. Take aggregate sample 5kg.
2. Before testing take dry weight with oven temp.105-110 degree Celsius.
3. Then, aggregate sample and steel balls are placed in machine and cover the machine fixed with nut bolts.
4. Start machine with speed 30 -33rpm. Number of revolution 500 given up to 30 minute.
5. Then, stopped the machine and removing the crushed material into a tray.
6. Crushed aggregate sieve using IS Sieve 1.70mm.

Abrasion Value = (w1-w2) / w1 *100

E. Aggregate Shape Test

Object- To determine the elongation index and flakiness index of the given test of aggregates.

Apparatus Required-
- Length gauge
- Thickness gauge
- IS sieves
- Weigh balance

Procedure-
1. Take dry aggregate sample
2. Sieve the aggregate using IS sieves
3. Then, mini 220 parts of each fraction take test and weight.
4. Using thickness gauge separate out flaky material.
5. Using length gauge separate out elongated material.
6. Flaky material passing on gauge takes weight.
7. Elongated material passing out on gauge takes weight.

3.2.2. Fine Aggregate

Sand is also called fine aggregates used in concrete. Natural river sand is a product of the natural weathering of rocks and due to the natural process of attrition, it tends to possess a smoother texture and better shape. River sand is commonly chosen as a fine aggregate that useful especially for construction purposes such as plastering work. This sand usually whitish-grey in color and has rounded particles. The moisture trapped between the sand particles makes the concrete workability higher.

It is defined by size it should be coarser than silt and finer than gravel. It is suitable for concrete work and it is a natural resource so, it's a demanding material. Take different tests and characteristics and zones of aggregate using code IS:383-456.

3.2.2.1. Tests on Fine Aggregate

These tests are conducted to find out the properties of fine aggregate.
1. Specific Gravity test of F.A.
2. Bulking of F.A.
3. Fineness modulus test of F.A.

A. Sp.Gravity And Water Absorption Test Of Fine Aggregate

Object – To determine the Sp.gravity and water absorption of fine aggregate.

Apparatus Required-
- Weigh balance.
- Pycnometer
- Oven with temperature 100 to 105 degree celsius.
- Tray
- Funnel and filter paper.

Procedure of test
1. Take sample of fine aggregate approximate 500gm.
2. Fine aggregate fill into pycnometer half of the top and water are filled up to top.
3. Then, removing the air by rotated of pycnometer.
4. Outer surface wipe out using cotton cloth and take weight (w).
5. Then, transfer material into a tray.
6. Again, completely filled of pycnometer with drinking water.
7. And taken weight (w1).
8. Those aggregate placing on tray, these are placing in oven with (100–105)-degreeCelsius temp.
9. Cooling the sample in room temperature and taken weight (w2).

Apparent specific gravity = (Weight of dry sample / Weight of equal volume of water)

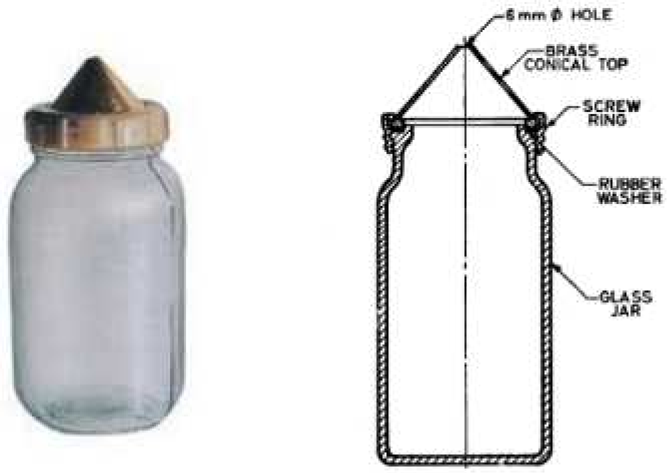

Figure 3.2SPgravity test of sand sample

B. Bulking Of Sand

Object - To determine the bulking value of sand.

Apparatus Required
- Measuring Cylinder
- Container
- Steel Rod (6mm dia.)
- Sand Sample

Test Procedure
1. Take the sample of sand and fill the measuring cylinder up to 200 ml.
2. Transfer that sample to a container again the measuring cylinder with 100ml water.
3. Now fill the fine aggregate into measuring cylinder and stir it well with the help of steel rod.
4. Allow it to settle sometime.
5. The fine aggregate will be below the 200ml mark as shown in the pic. Note this level as Y.
6. Repeat the same procedure for 2 more time.

Bulking of Sand = (200 – Y/Y) *100

C. Fineness Modulus of Sand

Object – To determine the size of sand particles using test of fineness modulus of sand.

Apparatus Requirement-
- Different sizes of sieves.
- Fine aggregate sample.

Procedure-
1. Take fine aggregate sample in required quantities.
2. Using sieves 300 micron, 600micron, 1.18mm, 2.36mm and 4.75mm sieving the fine aggregate.
3. Fine aggregate retained out on sieve weight noted.
4. Weight of fine aggregate retained out on each sieve to find out cumulative weight.
5. To find out cumulative percentages retained fine aggregate.
6. Cumulative weight of aggregate retained adding and divided sum by 100.
7. Find out this value termed as modulus of fineness of fine aggregate.

The Physical Properties are given in the Table

Table 3.3 Physical Property of Fine Aggregate

S. NO.	Particulars	Test Results
1.	Sp. Gravity	2.64
2.	Fineness modulus	2.45
3.	Free surface moisture	0.89%
4.	Water absorption	0.83%

Table 3.4 Physical Property of Course Aggregate

S. NO.	Particular	Result	Std. Value As
1.	Specific gravity	2.8	2.65-2.85
2.	Fineness modulus	5.68%	6-9
3.	Flakiness index	16.61%	<40%
4.	Elongation index	21.81%	<40%
5.	Crushing value	19.41%	<40%
6.	Impact value	17.80%	<44%
7.	Water absorption	0.61%	<3%
8.	Abrasion value	20.71%	<35%

3.2.3. M-Sand

It is also called artificial sand or crushed sand. it is produced by crushing hard granite stone in a stone crusher plant. It is easily available in the stone crusher plant where so much work is depending using a using stone-like- cement plant, coarse stone crusher plant and at a place of granite tiles milling factories, etc. in all work waist crush material called as dust or crusher dust. In this work collection of manufactured sand from a local dealer of manufactured sand from ratibadh m.p. It should be kept sun-dried and packed in waterproof bags. Before using m-sand in concrete. so, many tests are conducted to find out fineness modulus, density, the moisture content in the laboratory. Using sawdust in concrete reducing the dumping problem and prevention natural fine aggregate and increasing groundwater table reducing mining of river.

The behavior and characteristics of M-sand nearly the same as natural river sand so, it can be easily related to concrete. the specific gravity of M-sand 2.20 and M-sand sieve75micronsand 4.75mm IS sieves used. It is partially mixed with fine aggregate 50 and 100%.

3.2.3.1. Tests on M-sand

These are the following test to be conducted to find out properties of fine aggregate-

A. Specific gravity and water absorption and test of M-sand.
B. Sieve analysis test of M-sand.
C. Bulking test of M-sand.

A. Specific Gravity and Water Absorption Test of M-Sand.

Object – To determine the Sp.Gravity test of saw dust using pycnometer method**.**

Apparatus Required-
- Weigh balance with capacity 5 kg.
- Oven with temperature 100-105 degree Celsius.
- Pycnometer with capacity of 1 liter.
- Tray

Procedure-
1. Take fine aggregate sample 250gm.
2. Sample place into the pycnometer half of the top
3. Filled with water
4. Then, removing the air by rotating with hand.
5. Using cotton wipes out outer surface and take weight (w).
6. Now, pycnometer material is removed into a try.
7. Water removed out into a tray.
8. Now, pycnometer completely filled with water and take weight (w1).
9. Drain out sample using filter paper.
10. Tray sample placed in oven 24 hours with temperature 100-105 degree celsius.
11. After removing in oven and cooling the sample in room temp. and take weight (w2)

Sp.gravity = (weight of dry sample / weight of water)
= (w2 / (w-w2))

The above test Procedures are same as a fine aggregate test. And result are given in the table

Table 3.5 Physical properties of M-sand

S. No.	Particulars	Test Results
1	Sp. Gravity	2.20
2	Water absorption	1.96%
3	Fineness modulus	2.68%

Table 3.6 Chemical properties of M-sand

S.NO.	Element	Weight%
1	C	1.74
2	O	48.09
3	Na	2.69
4	Mg	2.45
5	Al	8.13
6	Si	18.45
7	K	2.84
8	Ca	3.68
9	Ti	1.86
10	Fe	10.06

B. Sieve Analysis Test of M-Sand

Object- to determine the particle size analysis by using sieve analysis method.

Apparatus Required-

Test Sieves conforming to IS: 460-1962 Specification of 4.75 mm, 2.36 mm, 1.18 mm, 600-micron, 300-micron, 150-micron, Balance, Gauging Trowel, Stop Watch, etc.

Procedure-
1. The sample shall be brought to an air-dry condition before weighing and sieving. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.
2. The shaking shall be done with a varied motion, backward sand forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions.
3. Material shall not be forced through the sieve by hand pressure. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve.
4. Light brushing with a fine camel hair brush may be used on the 150-micron and 75-micron IS Sieves to prevent aggregation of powder and blinding of apertures.
5. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Calculation:

Fineness modulus is an empirical factor obtained by adding the cumulative percentages of aggregate retained on each of the standard sieves ranging from 4.75 mm to 150 micron and dividing this sum by an arbitrary number 100.

Fineness Modulus (FM) = (Total of Cumulative Percentage of Passing (%) / 100)And result is given in the table:-

Table 3.7 Sieve Analysis Test of M-Sand

Is Sieve	% of Passing of M-Sand Sample
4.75mm	100.00
2.36mm	90.70
1.18mm	66.20
600 µ	39.80
300 µ	25.50
150 µ	9.90
Fineness modulus	*2.68*

Table 3.8 Wet Sieve Test to find the % Of Micro fines

Sample	Test	Result	Remark
Manufactured Sand	Material finer than 75 µ (%)	2.0	Finer than75 µ shall not exceed 3 % for uncrushed aggregate as per IS 383 – 1970

C. Bulking Test of M-Sand.

Object- To determine bulking of a given sample of fine aggregate.

Reference: IS: 2386 (Part III) - 1963

Theory: Free moisture forms a film around each particle. This film of moisture exerts what is known as surface tension, which keeps the neighboring particles away from it. Similarly, the force exerted by surface tension keeps every particle away from each other. Therefore, no point contact is possible between the particles. This causes bulking of the volume. It is interesting to note that the bulking increases with the increase in moisture content up to a certain limit and beyond that the further increase in the moisture content results in the decrease in the volume and at a moisture content representing saturation point, the fine aggregate shows no bulking.

Apparatus: Measuring jar, taping rod etc.

Procedure:

1. Put sufficient quantity of the sand loosely into a container. Level off the top of the sand and pushing a steel rule vertically down through the sand at the middle to the bottom, measure the height. Suppose this is h1 cm.
2. Empty the sand out of the container into another container where none of it will be lost. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder of the sand and rod it in the same way.
3. The percentage of bulking of the sand due to moisture shall be calculated from the formula:

Percentage Bulking = ((h / h1)-1) *100

3.3. Water

It is free from so many impurities such as acidity, alkalinity, colour, odour, chemicals etc. In this work distilled water are used obtained from Structure Engineering laboratory of MILLANIUM GROUP OF INSTITUTE was used for mixing and curing of concrete. Methyl orange indicator to find out alkalinity value. Generally acidic water is not suitable in concrete purpose. According to find out test result PH value of drinking water should not be less than 6. It should be free from other solid waste material like oil, sugar and organic substances.

Table 3.9 Water Properties

Property	Result	Requirement of IS:456-2000
Test		
Volume of 0.02 N NaoH Required to Neutralize 100ml Sample of Water using phenolphthalein as indicator, ml	2.6	5 Max
Volume of 0.02 N H2 SO4 Required to Neutralize 100ml Sample of Water using Mixed indicator, ml	8.8	25 Max
Solid Contents mg/l a. Organic b. Inorganic c. Sulphate d. Chloride e. Suspended Matter	 62.5 813 8.60 332.18 240	 200 Max 3000 Max 400 Max 2000(PCC)/500(RCC) 2000 Max
pH Value	7.39	Not Less than 6.0

Aggregate Cement M-sand River sand

Figure- 3.3 Material's Aggregate, cement, M-sand and sand

3.4. MIX DESIGN (M30)

Data Required for Concrete Mix Design Proportion for M30

1. Stipulations of Proportioning

a. Grade designation = M30
b. Type of cement = PPC (Mycem cement)
c. Maximum nominal size of aggregate = 20mm
d. Minimum cement content = 300kg/m3
e. Maximum water content ratio = 0.55
f. Workability = 75mm
g. Exposure condition = Mild (as per IS:456)
h. Method of concrete placing = By pan/bucket
i. Degree of supervision = Good
j. Type of aggregate = Crushed angular aggregate
k. Bulk density of cement = 1440kg/m3
l. Chemical admixture type = Not used

2. Test data for materials

a. Cement used = Mycem cement, PPC confirming IS:269
b. Specific gravity of cement = 3.15
c. Chemical admixture = Not used
d. Specific gravity

Coarse aggregate

1. 10mm = 2.877
2. 20mm = 2.798

Combined specific gravity = 2.88

Fine aggregate = 2.647

e. Water absorption

Coarse aggregate

1. 10mm = 0.78% (limit maximum 2%)
2. 20mm = 0.96% (limit maximum 2%)

Fine aggregate = 1.206% (limit maximum 2%)

Fine aggregate- Zone II of IS: 383

f. Free (surface) moisture

Coarse aggregate = Nil

Fine aggregate = Nil

g. Sieve analysis

1. Course

IS sieve size in mm	Analysis of course aggregate		Percentage of different fraction			Remarks
			20mm	10mm	combined	
	20mm	10mm	60.00%	40.00%	100.00%	Confirming of Table-2 of IS:383-1970
40	100	100	60.0	40.0	100.0	
20	97.43	100	58.46	40.0	98.46	
10	6.00	95.1	3.60	38.03	41.63	
4.75	0.78	4.14	0.47	1.66	2.12	

2. Fine aggregate = Confirming of grading zone II table-4 of IS:383-1970

3.4.1. Procedure for Mix Design Grade M 35

Step 1 – Target strength for mix proportioning:

ft = fck + K*s
= 30 + 1.65*5.0
= 38.25 N/mm^2

Where,
ft = Target strength of concrete in N/mm2
fck = Characteristics strength of concrete in N/mm2
S = Std. deviation in MPa (as per IS 10262-2009)
K = statistical coefficient = 1.65 (as per IS 456-2000)

Step 2 – Water Cement Ratio Selection:
As per IS 456—2000
Maximum Water cement ratio for mild condition = 0.55
Adopted water cement ratio = 0.38
0.38 < 0.55, OK

Step 3 – Selection of Water Content:
As per IS: 10262-2009
Maximum Content of water = 186 kg/m3
To achieve slump value 75mm slump 191.6kg/m3 water is necessary.
If slump value is more than 25mm water is increased by 30%.
Calculated Water Content = 186 + (3 / 100) * 186 = 191.6 kg/m3
There is no chemical admixture are used so, no changes in water content.

Step 4 – Cement Content selection:
Water cement ratio = 0.38
Adopted content of water = 191.6 kg/m3
Content of Cement = 191.6/0.38 = 504 kg/m3
As per IS 456:2000
Minimum Content of cement for mild condition = 300 kg/m3
504 kg / m3 > 300 kg / m3, OK.

Step 5 - Proportion of volume of coarse aggregate and fine aggregate content:
As per IS 10262

A. Nominal maximum size of aggregate = 20mm, fine aggregate zone II
For water cement ratio of 0.5 = 0.62 as per IS: 456

In present case water cement ratio is 0.38, therefore volume of coarse aggregate is required to be increase to decrease in fine aggregate. As the water-cement ratio is lower by 0.12, the proportion of volume of coarse aggregate is increased by 0.025 (at the rate of -+0.01 for every +- 0.05 change in water cement ratio). Therefore, corrected proportional of volume of coarse aggregate for the water cement ration of 0.38=0.645, p=0.645

B. The volume of fine aggregate, 1-p = 1-0.645 = 0.355
So proportion in volume = Course aggregate: Fine aggregate
64.5%: 35.5% (From calculation by IS:383 Table-5)

Step 6 - Calculation of the mix ingredients-

a. Vol. of Concrete = 1m3

b. Vol. of Cement = (Mass of cement / Sp. gravity of cement) * (1/1000)
= (504/3.15) * (1/1000)
= 0.16m3

c. Vol. of Water = (Mass of Water / Sp. Gravity of water) * (1/1000)
= (191.6/1) x (1/1000)
= 0.192 m3

d. Vol. of chemical admixture = Nil.

e. Vol. of total Aggregate = a - (b + c)
= 1 - (0.160 + 0.192)
= 0.648 m3

f. Coarse aggregate mass = vol. of total aggregate * vol. of C.A * Sp. Gravity of C.A * 1000
= 0.648 * 0.645 *2.88 *1000
= 1204 kg/m3

g. Mass of Fine Aggregates = vol. of total aggregate * vol. of F.A * Sp. Gravity of F.A * 1000
= 0.648 * 0.355 * 2.647 * 1000
= 609 kg/m3

Step 7 - Quantity of material's:
1. Cement = 504 kg/m3
2. Water = 191.6 kg/m3
3. Fine aggregates = 609 kg/m3
4. Coarse aggregate = 1204 kg/m3

Water cement ratio = 0.38

Concrete Mix Proportions for Trial Mix: - 1: 1.21: 2.39

3.4.2. Concrete Mix proportions for M 30 Grade-

Concrete mixtures were prepared with different proportions of fine aggregate and M-sand. The proportions (by weight) of F.A. and MS added to concrete mixture were as follows: -
0% (control mix), 50% and 100%. The mix proportion chosen for this study is M30 grade with water cement ratio of 0.38-0.40.

Final quantities of material after correction adjustment are suitable shown in table-

Table 3.10 Material for different percentages of mixes

S. No.	Fine aggregate % (River sand)	Fine aggregate % (M-sand)	Cement (kg/m3)	Fine aggregate (kg/m3)	Coarse aggregate (kg/m3)	M-sand (kg/m3)	Water (kg/m3)
1.	100	0	504	609	1204	0	191.6
2.	50	50	504	304.5	1204	304.5	191.6
3.	0	100	504	0	1204	609	191.6

The methodology of the work is shown by flow chart:

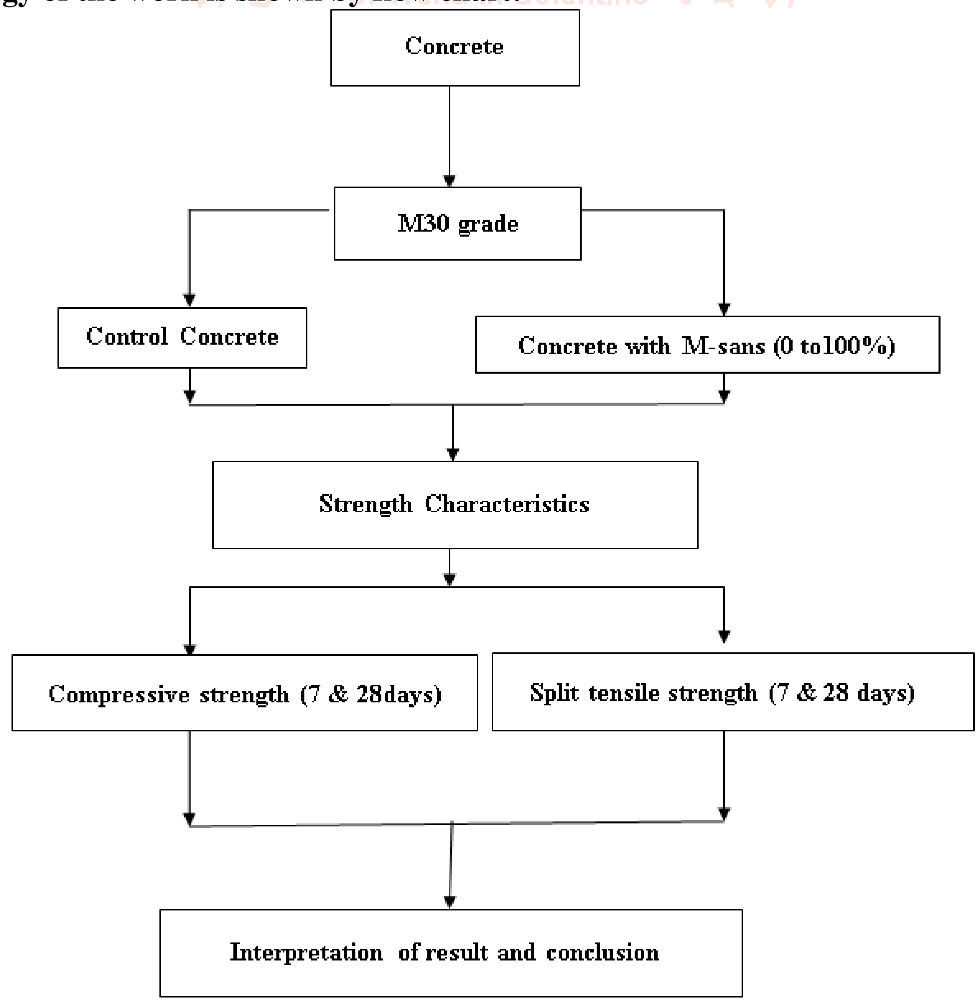

Figure 3.5.1 Flow chart

3.5. Test Procedures

3.5.1. Workability

Workability of concrete is the ease with which concrete can be properly mixed, transported, compacted and finished, with minimum loss in homogeneity. Slump test is the most extensively used test to measure workability of concrete all around the world in construction sector. Workability of the concrete was evaluated by slump test as per Indian Standard Specifications given in BIS 1199:1959. A mould in the form of frustum of a cone with bottom diameter 200mm, top diameter 100mm and height 300mm was filled with four approximately equal layers, tempering each layer with a standard tempering rod with 25 strokes.

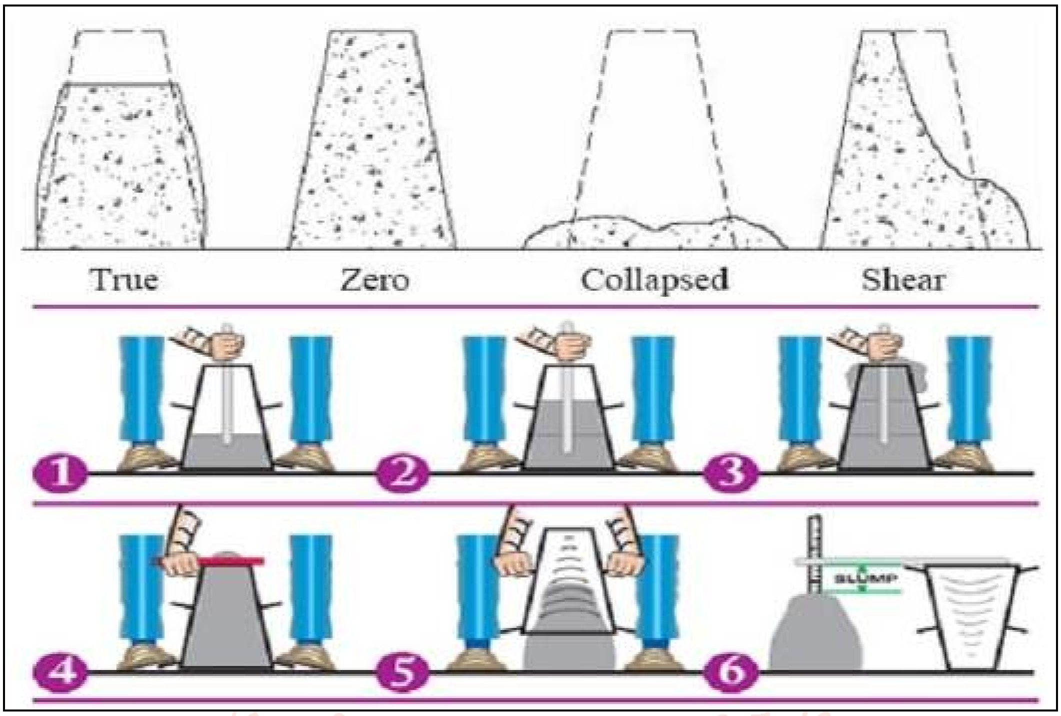

Figure 3.2 Slump Test of Concrete

After filling and leveling the surface, mould was removed by lifting it in vertical direction, allowing concrete to subside. Results of the workability testing were reported as slump in mm,

This is the difference between height of the mould and that of highest point of subsided concrete mass.

3.5.2. Workability test on fresh concrete

To study of the workability of concrete of given mixture by determining the slump value of Concrete mixture for various percentage of water content.

A. Apparatus required

- Slump cone
- Weighing balance with weight
- Measuring scale
- Measuring jar
- Trowel and
- Tamping rod

PROCEDURE-

The slump cone is placed on a water tight leveled platform and fresh concrete is placed in three layers. Every layer is ramped with 25 blows by tamping rod of 16mm dia. And 60mm long. After filling the slump cone, the cone is gently and vertically raised, the concrete is allowed to settle under its own weight. The vertical distance from the before level to the new level after subsidence is measured. This is called slump and is measured in mm. The above procedure is repeated for different-different water cement ratio.

a. TRUE SLUMP

True slump is defined as a cone the uniformly mixture and cohesively. This type of slump in normally obtained in rich mixture and where the proportion of fine aggregate is more.

b. SHEAR SLUMP

Shear slump half of the cone shears off along the inclined plane while the other half is true slump.

Slump value is measured from cone level to the centre of the shear plane. The shear slump is obtained in the first instance. The test should be repeated.

c. COLLAPSE SLUMP

Collapsible slump is defined as a slump the concrete first collapses and then spreads over a larger area. This phenomenon normally occurs in wet mixture.

3.5.3. Compressive Strength

Compressive strength is regarded as the most important property of hardened concrete. Compressive strength test was done as per Indian Standard Specifications, according to the procedure given in BIS 516:1959. Compressive strength of concrete was evaluated at age of 7 days, 28 days and 90 days using standard cube specimens of 150mm×150mm×150mm. Compression Testing Machine (CTM) of 5000kN capacity was used for the testing of compressive strength of concrete. Concrete specimen was be molded 24 hours after the casting and placed in the curing tank to ensure sufficient curing. At each specified age, specimen was placed centrally between the bearing plates of CTM and load was applied continuously and uniformly at specified loading rate of 140 kg/cm2/min. the load was increased until the specimen broke and the maximum The compressive strength was calculated according to the following formula:

Load taken by each specimen was noted down.

$$\sigma = P/A$$

Where,
σ = compressive strength (N/mm2)
P = Maximum load sustained by the cube (N)
A = Area of cross section of cube (mm2)

Results of the compressive strength testing were reported as average of compressive strength of 3 specimens at 7 days, 28 days and 90 days for each concrete mix in N/mm2.

3.5.4. Density of Concrete

Density of concrete is an important aspect, as it plays a major role in the calculation of dead weight of a structure. At the time of dismantling of cubical specimens of 150mm×150mm×150mm used for testing of compressive strength, mass of 3 random cubes was taken using a weighing balance of 10 kg capacity with an accuracy of 1.0g and 1-day density of concrete was calculated from the following formula:

$$\rho = M / V$$

Where,
ρ = Density of concrete in kg/m3
M = Mass of 150mm×150mm×150mm cube in kg
V = Volume of cube in m3

3.5.5. Splitting tensile Strength

As concrete is strong in compression, but very weak in tension, so it is necessary to determine the tensile strength of the concrete so as to prevent cracking in tension zones. Splitting tensile strength is an indirect method to determine tensile strength of concrete. Splitting tensile strength test was done as per Indian Standard Specifications, according to the procedure given in BIS 5816:1999. Splitting tensile strength of concrete was evaluated at age of 7 days, 28 days and 90 days using standard cylindrical specimens of 150mm diameter and 300mm height. Concrete specimen was remolded 24 hours after the casting and placed in the curing tank to ensure sufficient curing. Compression Testing Machine (CTM) of 5000kN capacity was used for the testing of compressive strength of concrete. For the evaluation of splitting tensile strength, each top and bottom to ensure proper distribution of load as shown in Figure 3.4. Load was applied continuously and uniformly at specified loading rate of 1.2 N/mm2/min to 2.4 N/mm2/min. The load was increased until specimen was placed centrally between the bearing plates of CTM with suitable packing strips at the specimen cracked along the vertical plane and the maximum load taken by each specimen was noted down. The splitting tensile strength was calculated according to the following formula:

$$\sigma st = 2P / \pi DL$$

Where,
σst = Splitting Tensile Strength (N/mm2)
P = Maximum load sustained by the cylinder (N)

D = Diameter of cylinder (mm)
L = Length of cylinder (mm)

Results of the splitting tensile strength testing were reported as average of splitting tensile of 3 specimens at 7 days, 28 days and 90 days for each concrete mix in N/mm2.

Figure 3.5.3 Splitting Tensile Strength Test of Concrete

Since concrete does not take have any tensile strength it is taken as zero. But, IS code recommends the tensile strength to be calculated using Fcr = 0.7root fck N/mm2.

1. Flexural tensile strength –tensile strength of concrete in flexure is called flexural strength. Flexural strength is used to determine the onset of cracking or the loading at which cracking starts in structure.

It is measured by testing beams under 2-point loading (also called 4-point loading including the reactions).

2. Splitting tensile strength – it is measured by testing cylinders under diametrical compression. Because due to difficulty in applying uniaxial tension to a concrete specimen & hence the tensile strength is determined by indirect method i.e. by split tensile strength test.
3. Direct tensile strength – it is measured by testing rectangular specimen under direct tension. In the absence of test results, the code recommends to use an estimate of the flexural tensile strength from the compressive strength by the following equation

$$F_{cr} = 0.7\ (f_{ck})\ ^{0.5}$$

Where, fcr = flexural tensile strength in N/mm2

fck = characteristic compressive strength of cube in N/mm2

$$F_{ct} = 0.66 * f_{cr}$$

Fct = splitting tensile strength & direct tensile strength = (0.5 - 0.625) fcr

3.6. EXPERIMENTAL TECHNIQUES

The M-sand concrete test using cubes and cylinders of various mixes was tested for compressive, and split tensile strength at 7 and 28 days in MILLANIUM GROUP OF INSTITUTE laboratory. The testing procedures, testing machines, importance of the tests, and calculations are given below:

The following are the tests which were conducted in the project: Strength Tests:
- Compressive strength test using cube
- Split tensile strength test using cylinder

In the present study according to IS standards, the following dimensioned specimens were cast •150*150*150 mm of cubes, and
- 150*300 mm of cylinders

Achieving the objective of the work, the following procedural steps are followed:
1. Batching
2. Mixing
3. Casting of the cube, cylinder, and beam
4. Compaction
5. Curing
6. Testing

3.6.1. Preparation of test specimen
For every mixture, mixing the material in the required amount and batched. Mixing of concrete using 50kg capacity drum in the M.I.T.S. lab. The drums were washed and dry the drum before use. Coarse Aggregate and Fine Aggregates were placed and mixed thoroughly then Cement is added and mixed. Water is applied slowly on the dry mix and mixing of material till 2 minutes. Then fresh concrete becomes homogeneity.

3.6.2. Procedure of batching
Batching is the process of measuring the quantities of concrete by vol. for the preparation of concrete mix. In this study weight batching method is adopted to measure the quantities of fine aggregate, cement, coarse aggregate, and M-sand. For mix proportions for design were measured by using weighing balance. The ingredients of concrete in the required quantities were enhanced into the capacity laboratory concrete mixer. After thorough mixing i.e. achieved uniform color, workable consistency to concrete, the concrete was conveyed into a tray for casting specimens.

3.6.3. Procedure of mixing
First of all, mixing of concrete uniformly to give accurate test results. Initially, coarse aggregate is a sieve and weight for the required amount and take tray 1, then, fine aggregate is weighed for the required amount and take tray 2, now cement is weighed and take tray 3, after, mixing all material firstly coarse aggregate mix with fine aggregate properly than cement is mixing uniformly for all-sided, water is applied slowly for covering all area. Mixing of concrete minimum 5 minutes than uniform colors of concrete is seen. Conducted slump value test of fresh concrete and filled in a mold as per the above procedure.

For M-sand concrete partially replaced of M-sand using different percentage above procedure is followed, coarse aggregate mixed with fine aggregate and M-sand are thoroughly mixed, cement mixed and all mixture are properly mix by drum and provide water slowly mixing of concrete up to 5mim. Concrete gives a uniform color.

The same procedures are followed again and again replacement of fine aggregate with 0, 50, and 100% of M-sand.

3.6.4. Testing of fresh concrete
Using the slump cone test to find out the degree of workability of manufactured sand concrete and control concrete. Using the different percentages of M-sand in concrete could be affected by workability. This is a simple and accurate test for finding out the workability of concrete. The workability of concrete is directly depending on the water-cement ratio.

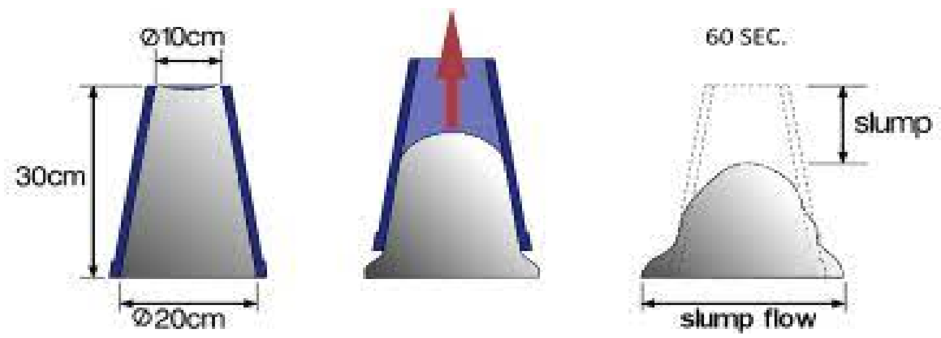

Figure: Workability test by slump cone method

3.6.5. Casting, Compaction and Curing Procedure

3.6.5.1. Casting and curing of cubes specimen

Take dry cube shape molds and their inner surface are coated with oil and placed on a granite surface. Then, the material was weighed for the required amount, properly mixed, and measure the workability of fresh concrete and then filled in a mold with three equal layers and each layer tamped by temping rod given 25 blows for each layer top surface of mould is finished using the trowel. mould is kept at room temp. for 24 hours covering with gunny bags content moisture. After 24 hrs. mould was slowly removed and cubes were kept in a water tank for curing. Cubes are fully immersed in a water tank for different days 7, and 28 days.

Above same procedure are follows, again and again, control concrete and using M-sand with partial replacement of fine aggregate for different percentage 0, 50%, and 100%. Firstly, take dry surface cylindrical mould inner surface of mould filled with oil and mould is placed on a granite surface. Then, weighing the required amount of concrete material. The materials were dry mix and after mixing provide distilled water thoroughly mixing of concrete up to 5-minute mixing. To find out the workability of fresh concrete using slump cone test conducted. Then, cylindrical mould was filled concrete with four equal layers and each layer give thirty-five blows by temping rod. Completely filled with cylinder top layer was finished with a trowel. Cylindrical mould was kept at room temp. 24 hrs. Covered with gunny bags. After 24 hours mould is removed and concrete cylinder is completely immersed in a water tank in the lab. For curing for required period 7, and 28 days respectively. The same procedures are followed again and again.

3.6.5.2. Casting and curing of concrete specimen

Firstly, take a beam mould inner surface of mould were coated with oil and placed on granite surface. Required material was weigh and filled in mixture and mix dry material and then apply drinking water thoroughly up to five-minute mixing the concrete and its give uniform color Experimental study on partial replacement of fine aggregate with manufactured sand for M30 grade of concrete than testing of workability of concrete conducted slump cone test of concrete. Then concrete was filled in mould in three equal layers and each layer was tempted by temping rod 35 blows. Top surface of mould is finished by trowel. Beam mould was kept in 24 hours cover with gunny bags in room temp. After 24 hours beam mould was removed and concrete beam specimen fully immersed in water for curing 7, and 28 days.

3.6.6. Testing of hardened concrete

3.6.6.1. Compressive strength test

It is defined as a property of a material to compressibility. When a compressive force is applied on the cube to find out the bearing capacity of material in this test using compressive strength testing machine 40-tonne loading are provided. The specimen is placed in the machine properly and then starts the machine using a switch on gradually loads are applied up to ultimate loading after maxi. Loading concrete specimen was cracks or failure this point should be noted and find out the compressive strength of cube using formula load per unit volume in kilo Newton per meter square or newton per millimeter square. The standard size of the cube according to IS: 456, 150*150*150* Millimeter cube.

Compressive strength of cube using formula-

Compressive Strength = P / A in N/mm^2

Where, P= load in N,

A=area in mm2

After the required curing period cube specimens are taken out in a water tank and kept in a surface dry condition for up to 30 min. then, performed a compressive strength test in compressive strength testing machine in the laboratory.

40-tonne load capacity of the machine. Cube specimen is placed in the testing machine properly centering than machine switch on applied loading gradually maxi loading provided up to the failure of cube specimen. Noted load in which point cube was a failure and find out compressive strength using above formula.

3.6.6.2. Tensile strength test of concrete using cylinder

It is defined as a tension property of concrete. We know that concrete was weak in tension and strong in compression. We can find out tensile strength test of concrete using a concrete cylinder. A compression strength testing machine was used for testing a cylinder. In-cylinder two equal and opposite direction of two ends surface of testing machine in between cylinder were placed. Due to providing compressive load cylinder was showing

maxi. The magnitude of compressive stress near the loading area. The maximum area of cylinder length and depth subjected to uniform tensile stresses.

To find out tensile stresses of concrete using this formula-

$$\sigma = 0.637 \, P / DL$$

Where,
P= Tensile force in N
D= Dia. of cylinder
L= Length of cylinder

Testing of concrete cylinder specimen

After the required period of curing of the cylinder taken out in the water tank and placed on surface dry condition for up to 30 minutes. Then concrete cylinders are placed in a compressive testing machine properly in between them. Then, the switch on the machine started and load is applied to the cylinder was gradual up to maximum loading bear by cylinder after maximum load it was failure. These failure point load noted. 40-tonne loading capacity of the machine.

Wood pieces have placed on both sides of the cylinder just because the direct load is not applied to the cylinder. Find out the tensile strength of the cylinder using by the above formula.

4. RESULT AND DISCUSSION

In the chapter of result and discussion show that complete reports of all test result in those tests was performed and also describe particle size analysis using IS Sieve and sp. gravity of M-sand mixed with fine aggregate. It's showing by chart and graphical representation.

4.1. Particle Size Distribution

Using the different sizes of sieves to get the distribution of particle size fine aggregate mixed with M-sand (0%, 50%, and 100%).

Particle-size distribution for different percentage of partial replacement of fine aggregate with m-sand shown by table given below-

Table 4.1 Particle Size Distribution Details of sieve analysis of natural sand and manufactured sand

Sieve designation	percentage passing of zone II sand		Grading limit for zone II sand (IS:383)
	Natural sand	Manufactured sand	
4.75mm (No.4)	94.75	100	90-100
2.36mm (No.8)	88.5	88.1	75-100
1.18mm (No.16)	71.25	68.5	55-90
600 microns(NO.30)	42.5	37.5	35-59
300 micron (No.50)	11.5	15	8-30
150 macron (No.100)	1.75	6	0-10

The above table shows the particle size distribution of the natural sand and manufactured sand will act as sand and even as an Experimental study on partial replacement of fine aggregate with M-sand for M30 grade of concrete 49 mineral fillers by virtue of the distribution. Proportions of materials retained on a 4.75 mm sieve were weighed and used for the mixes. This was done to avoid altering the properties of the other components of the mix. The effect here is that M-sand will replace mostly the fine aggregate.

4.2. Specific gravity

Specific Gravity of the fine aggregate mixed with M-sand shows the result that can be used further for mixed design purposes.

Table 4.2 Specific gravity of M-sand mixed with fine aggregate

	Natural sand (100%)	Natural sand (50%) Manufactured sand (50%)	Manufactured sand (100%)
Specific gravity	2.64	2.42	2.20

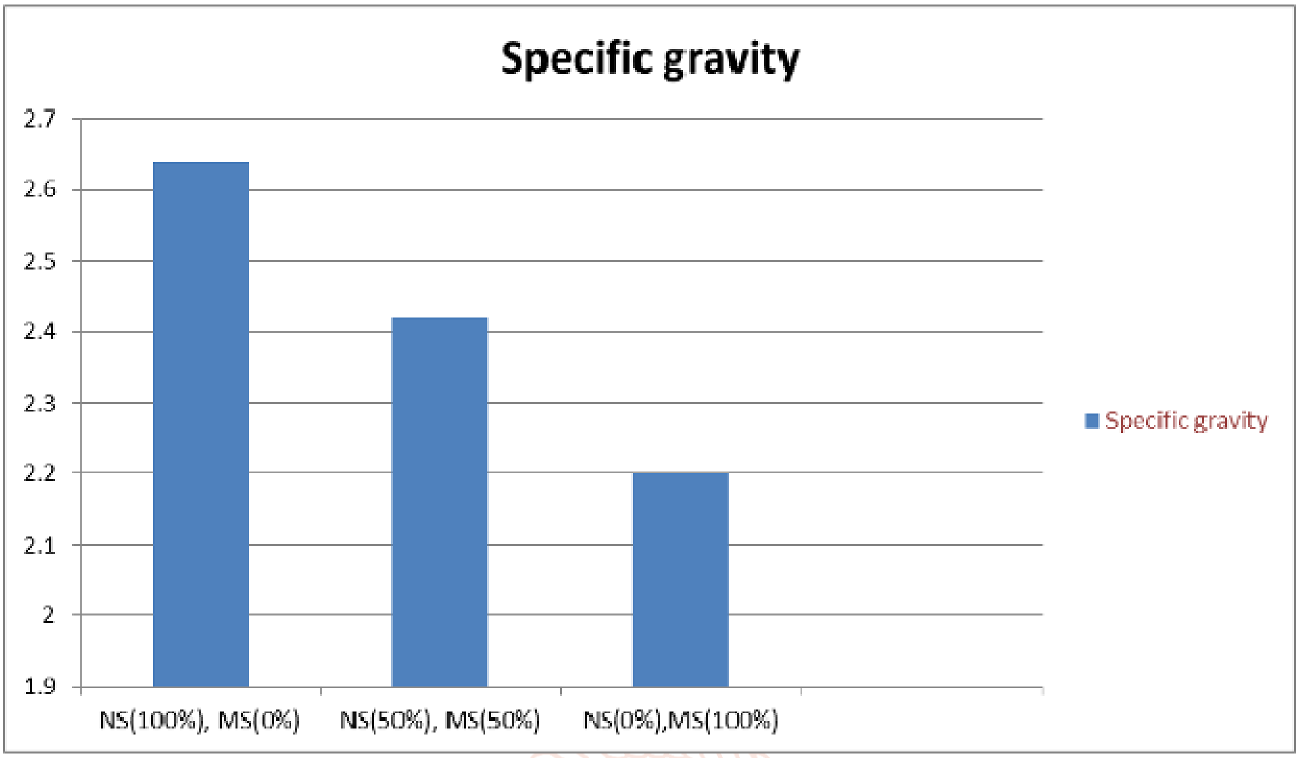

Figure-4.1 Bar chart show Sp. Gravity of concrete

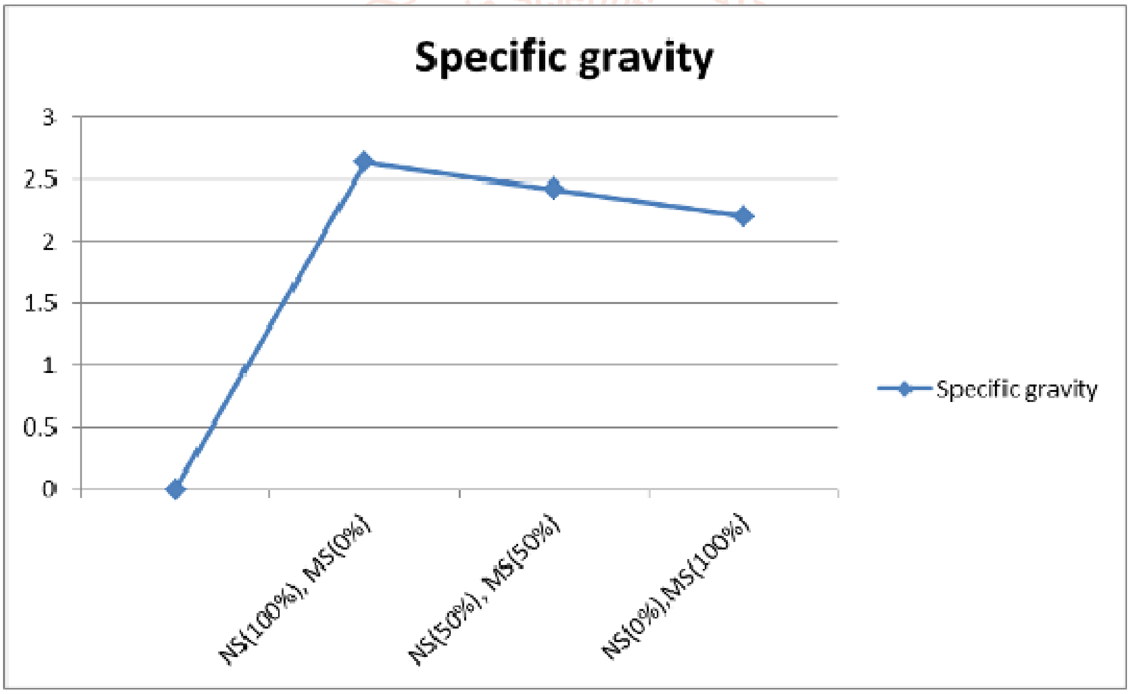

Figure-4.2 Line chart show Sp. Gravity of concrete

4.3. Workability

It is defined as a property of freshly mixed concrete. This determines the easy handling, mixing, and placing of concrete.

Slump values are different percentages of manufactured sand with partial replacement of fine aggregate shown given below table-

Table 4.3 Slump value for different % of M-sand

F.A. Replacement by M.S. in %	Slump Value (mm)
0	85
50	81
100	75

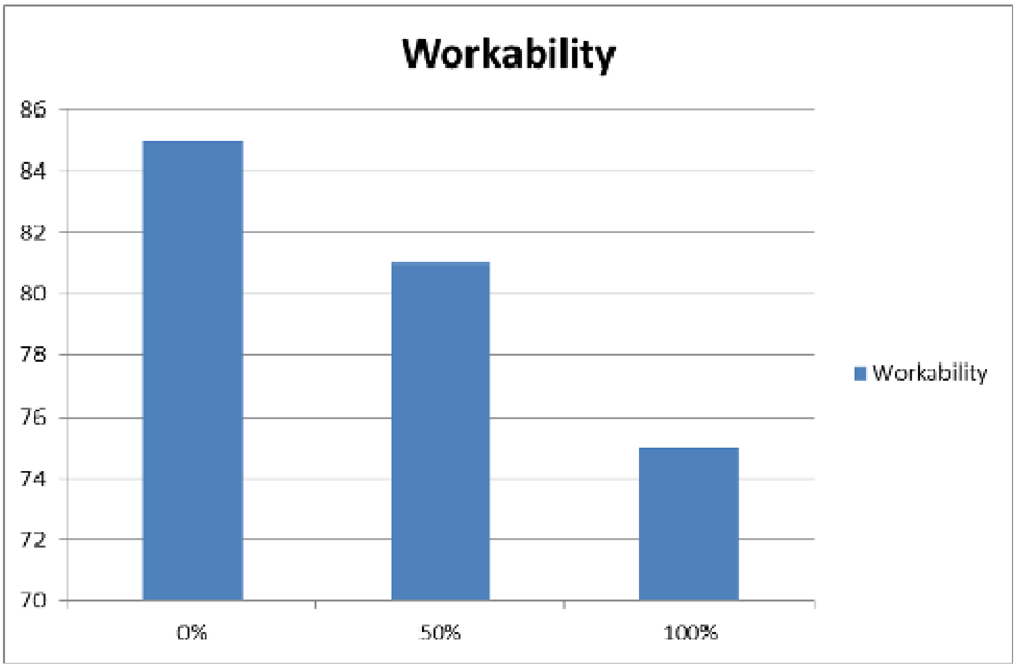

Figure-4.3 Bar chart show workability of concrete

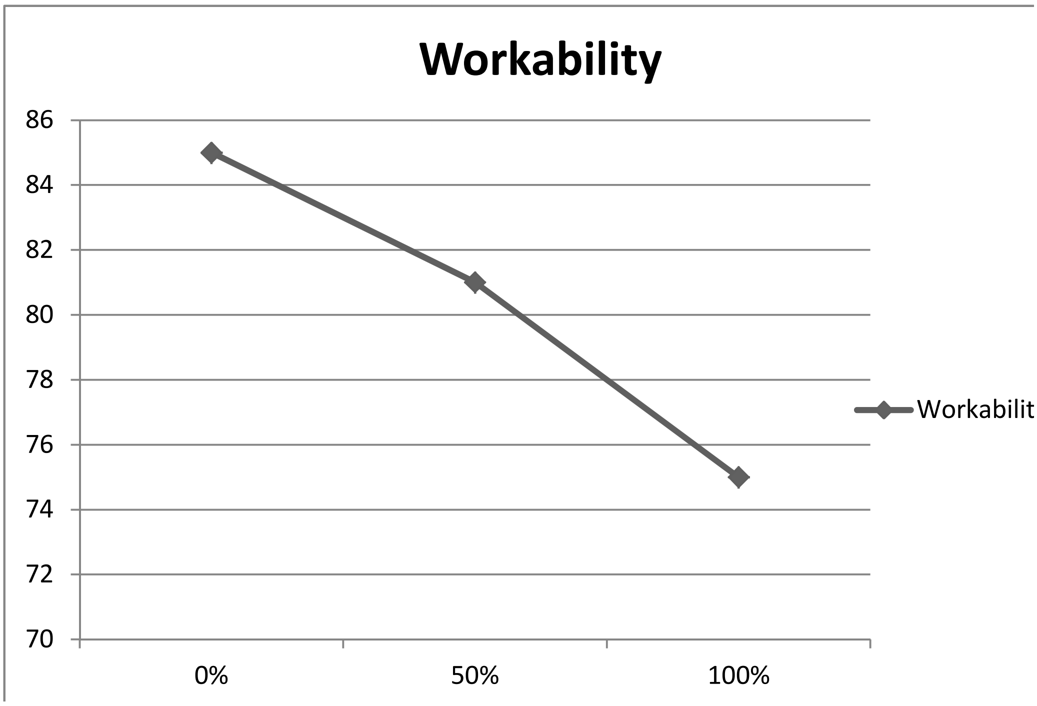

Figure-4.4 Line chart show workability of concrete

4.4. Compressive Strength

It is defined as a property of concrete to resist compressive force. It is the important property of concrete. Structural members are resisting compressive load is very imp. So, it is the main purpose to analyze compressive strength values. And also, be resisting external forces.It is calculated by force per unit area in Newton per meter square. In this test, it is found out M-sand % increasing with natural sand affects the compressive strength value in 100 % replacement.

In this test, it is finding out m-sand % increasing with an increase in the compressive strength values after 50 % replacement. The reason for the decrease in strength of concrete is usually the entrapped air present in the concrete mix or either depends on the ratio of cement and water in certain amount. These qualities actually affect the hydration of cement and hence the growth of strength. Additionally, the minimum compressive strength values could be due to the air trapped in the concrete mix which is an experimental study on partial replacement of fine aggregate with m-sand for M30 grade of concrete known to cause a reducing the strength. Batch to batch mixing shows bound together and shows different results of mixes.

Compressive strength values for different percentage of M-sand with fine aggregate shown in the table given below-

Table 4.4 Compressive strength value of concrete in MPa (N/mm2)

Sample Designation (M-sand in %)	Breaking load (KN)	Average compressive strength @ 7 days (N/mm2)	Breaking load (KN)	Average compressive strength @ 28 days (N/mm2)
0	Sample-1 = 453.3 Sample-2 = 479.9 Sample-3 = 466.8	Sample-1 = 20.147 Sample-2 = 21.329 Sample-3 = 20.747 Avg.= 20.714	Sample-1 = 713.6 Sample-2 = 686.2 Sample-3 = 745.8	Sample-1 = 31.716 Sample-2 = 30.496 Sample-3 = 33.147 Avg.= 31.786
50	Sample-1 = 416.6 Sample-2 = 452.3 Sample-3 = 496.7	Sample-1 = 18.516 Sample-2 = 20.102 Sample-3 =22.076 Avg.= 20.231	Sample-1 = 807.3 Sample-2 = 795.7 Sample-3 = 817.1	Sample-1 = 35.880 Sample-2 = 35.364 Sample-3 = 36.316 Avg.= 35.853
100	Sample-1 = 447.9 Sample-2 = 411.2 Sample-3 = 459.8	Sample-1 = 19.907 Sample-2 = 18.276 Sample-3 =20.436 Avg.= 19.540	Sample-1 = 663.3 Sample-2 = 782.3 Sample-3 = 729.4	Sample-1 = 29.489 Sample-2 = 34.769 Sample-3 = 32.418 Avg.= 32.225

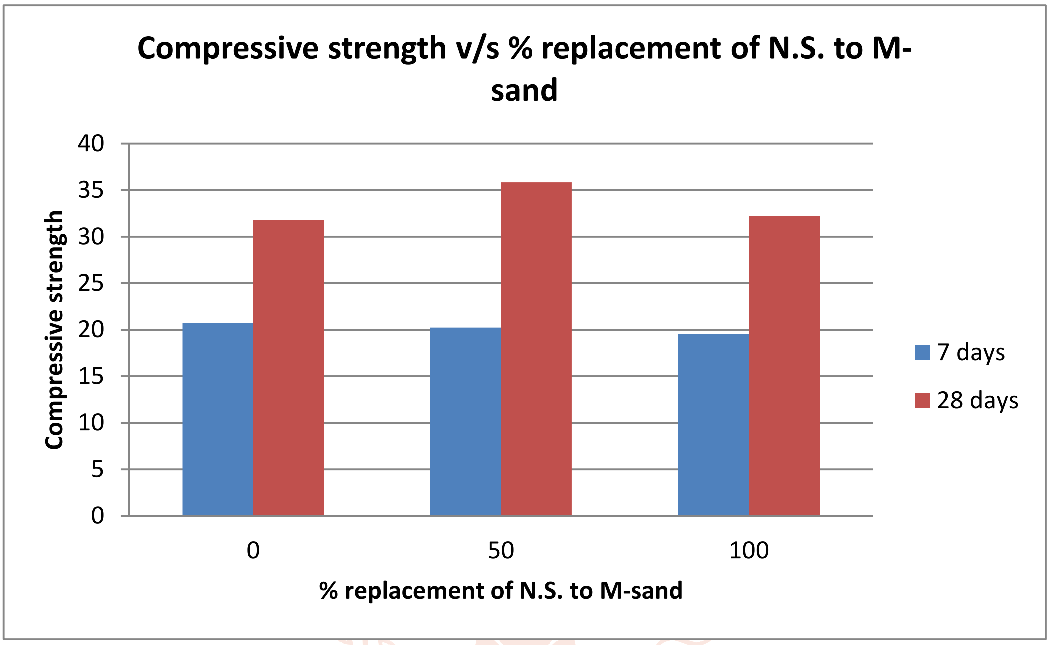

Figure-4.5 Bar chart showing compressive strength values

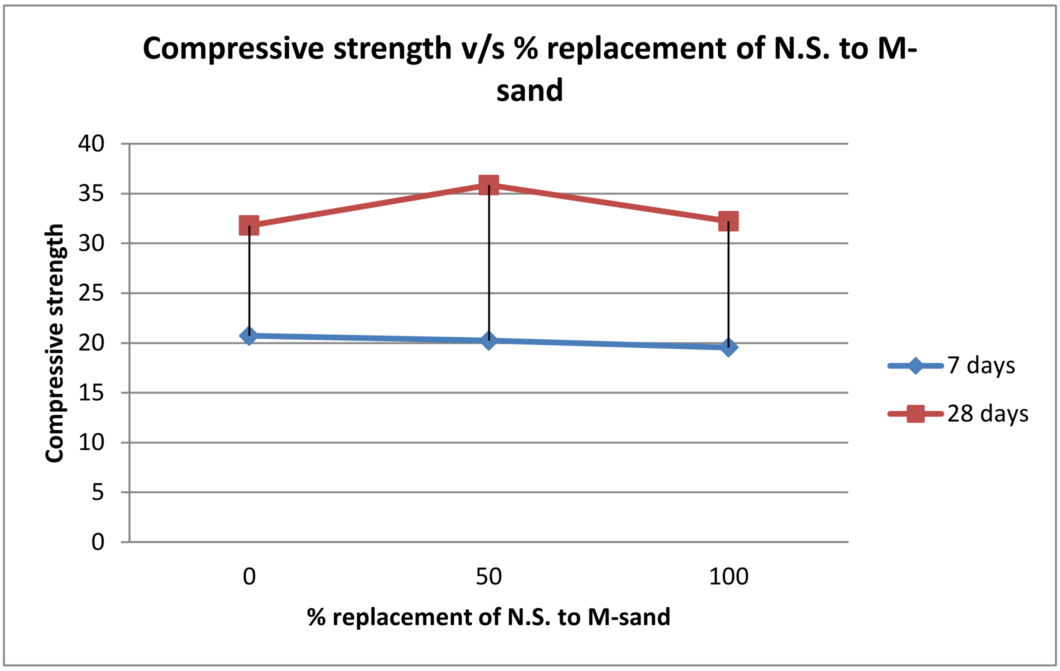

Figure-4.6 Line chart showing compressive strength values

4.5. Tensile Strength of Cylinder

It is defined as tensile strength as the most important property of concrete. Split tensile strength test to be conducted for determining the strength of concrete using cylinder specimen. Generally concrete is weak in tension just because of its brittleness properties. So, therefore it can easily show cracks when concrete subjecting to tensile force.

Tensile strength values for different percentage of M-sand with fine aggregate shown in the table given below-

Table 4.5 Tensile strength values of concrete cylinder

Sample Designation (M-sand in %)	Breaking load (KN)	Average tensile strength @ 7 days (N/mm2)	Breaking load (KN)	Average tensile strength @ 7 days (N/mm2)
0	Sample-1 = 140 Sample-2 = 130 Sample-3 = 145	Sample-1 = 1.996 Sample-2 = 1.853 Sample-3 = 2.067 Avg.= 1.972	Sample-1 = 220 Sample-2 = 240 Sample-3 =225	Sample-1 = 3.114 Sample-2 = 3.397 Sample-3 = 3.187 Avg.= 3.233
50	Sample-1 = 170 Sample-2 = 155 Sample-3 =200	Sample-1= 2.406 Sample-2 =2.194 Sample-3 = 2.831 Avg.= 2.477	Sample-1 = 230 Sample-2 = 270 Sample-3 =305	Sample-1 = 3.255 Sample-2 = 3.822 Sample-3 = 4.317 Avg.= 3.798
100	Sample-1 = 190 Sample-2 = 140 Sample-3 =165	Sample-1 = 2.689 Sample-2 = 1.982 Sample-3 = 2.335 Avg.= 2.335	Sample-1 = 225 Sample-2 = 245 Sample-3 =265	Sample-1 = 3.187 Sample-2 = 3.468 Sample-3 = 3.751 Avg.= 3.469

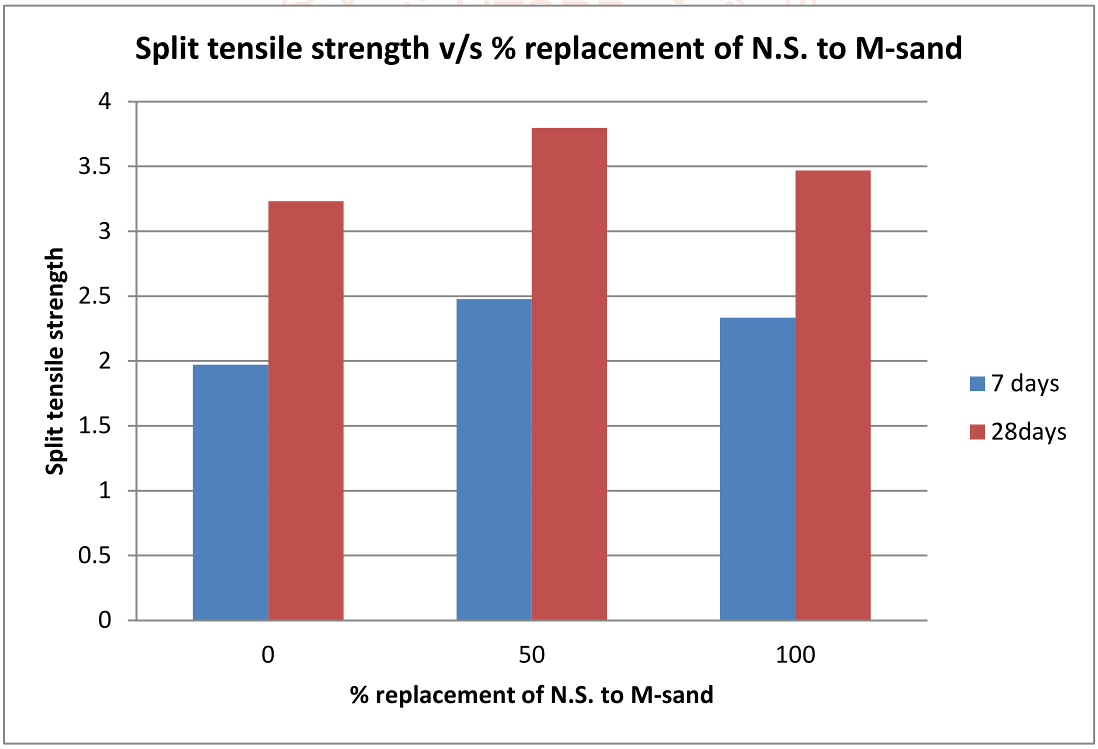

Figure-4.7 Bar chart showing Tensile strength values

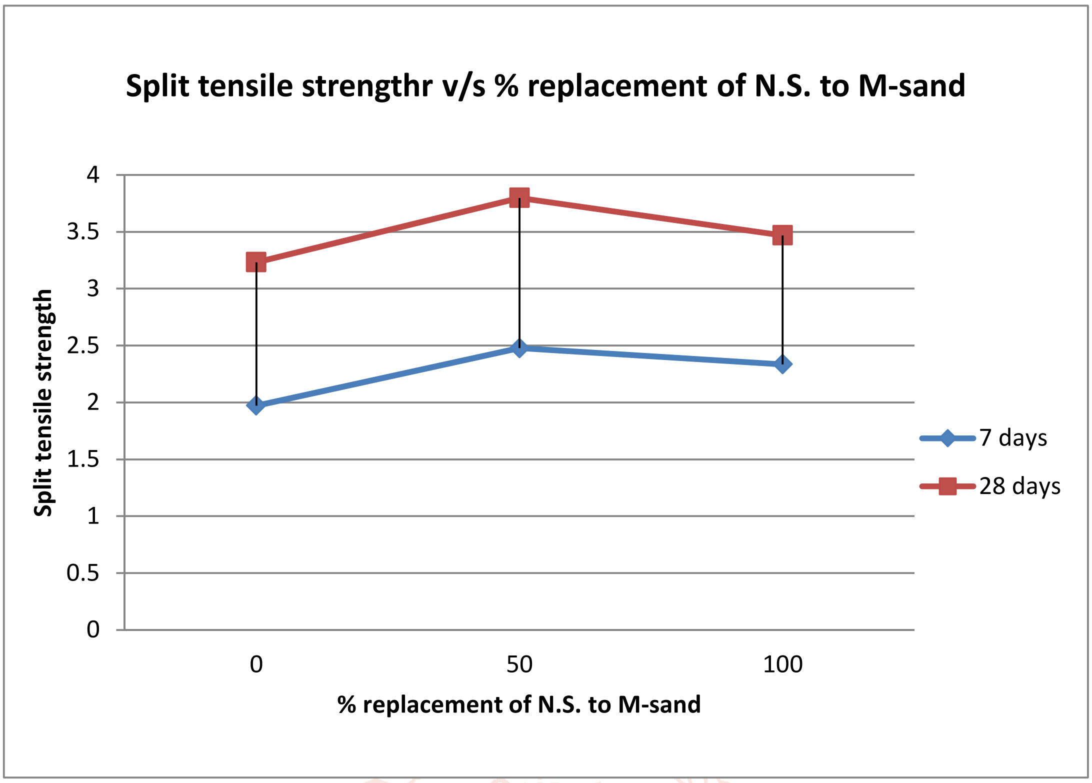

Figure-4.8 Line chart showing Tensile strength

5. CONCLUSION AND FUTURE WORK

5.1. Conclusion of the study

In this investigation to find out so many possibilities of manufactured sand using as a replacement of fine aggregate in concrete. Finally, analyze and compare the result to be obtained with conventional concrete. On the basis of the above experimental investigation, these are following conclusion are given below-

1. M-sand is the replacement of fine aggregate 0, 50, and 100%, express the same properties of normal concrete. And also, we can find out sieve size analysis and coefficient of consolidation also is same.
2. Using coarse aggregate and fine aggregate in the mixture we can find physical properties test physical properties of fine aggregate and m-sand are nearly the same.
3. On the basis of chemical properties, we can find out a partial replacement of fine aggregate with M-sand it shows similar properties and no observe any percolating issue and it should not react to any other ingredients like water, cement, and coarse aggregate.
4. In this investigation we can find out increasing the % of manufactured sand with fine aggregate decreasing the workability value and also, we can observe that increase the compressive strength value, split tensile value is higher at more than 50% replacement.
5. On the basis of the above discussion, it concluded that 50% and more value of replacement at a higher level to 100% replacement of fine aggregate with manufactured sand is optimum value.
6. On the basis of the above discussion, it can be concluded that using the M-sand as a replacement of fine aggregate provides a safe healthy and green environment, and it's suitable for all construction work.

5.2. Future work

Based on the above analysis, using concrete complete replacement of fine aggregate with M-sand the following future study can be suggested –

1. Manufactured sand collected from different stone crusher plants and replacing for different percentages with fine aggregate.
2. There are so many possibilities adding different admixtures increasing the strength and other properties of concrete.
3. Adding admixture of concrete testing and analyzing the results.
4. Fire and thermal insulation properties also are tested.
5. Generally concrete mix with manufactured sand is less workable as compared to the natural sand concrete mix, so need to test water absorption property at different ratios.
6. Auxiliary research work is required for this M-sand as a partial replacement of fine aggregate thermal and strength variation properties to be confirmed.

References

[1] S. Elavenil and B. Vijaya, "Manufactured Sand, A Solution and An Alternative to River Sand in Concrete Manufacturing," *International Journal of Civil Engineering Research and Development (IJCERD),* vol. 3, no. 4, pp. 01-07, 2013.

[2] N. Vijayaraghavan and A. S. Wayal, "Effect of Manufactured Sand on Compressive Strength and Workability of Concrete," *International Journal of Structural and Civil Engineering Research,* vol. 2, no. 1, 2013.

[3] M. B. Chougule and M. V. M. Chougule, "An Experimental Study on the Concrete Prepared with Natural and Artificial Sand," *Internation Advanced Research Journal in Science, Engineering and Technology,* vol. 7, no. 8, 2020.

[4] J. Thivya and A. Aarthi, "Comparative Analysis of River Sand, M-Sand and Quarry Dust," *International Research Journal of Engineering and Technology (IRJET),* vol. 06, no. 05, pp. 923-927, 2019.

[5] V. R. Supekar and P. D. Kumbhar, "Properties Of Concrete By Replacement Of Natural Sand With Artificial Sand," *International Journal of Engineering Research & Technology (IJERT),* vol. 1, no. 7, 2012.

[6] K. R. Chandar, B. C. Gayana and V. Sainath, "Experimental Investigation for Partial Replacement of Fine Aggregate in Concrete with Sandstone," *Advance in Concrete Construction,* vol. 4, no. 4, pp. 243-261, 2016.

[7] S. Sinha, N. Khan and P. Soni, "An Experimental Study on Effects of Quarry Dust as Partial Replacement of sand in Concrete," *International Research Journal of Engineering and Technology (IRJET),* vol. 04, no. 11, pp. 2021-2023, November 2017.

[8] K. M. Mane, D. D. K. Kulkarni and A. A. Joshi, "Strength and Workability of Concrete With Manufactured Sand," *International Journal of Engineering Research and Technogy,* vol. 10, no. 1, pp. 331-335, 2017.

[9] K. B. Dashrath, V. P. Kulkarni, S. B. Kandekar and A. J. Mehetre, "Compression and Split Tensile Strength of Concrete Containing Different Aggregates," *International Journal of Engineering Research & Technology (IJERT),* vol. 3, no. 3, pp. 469-473, March 2014.

[10] P. A. Jadhav and D. K. Kulkarni, "Effect of Replacement of Natural Sand by Manufactured Sand on the Properties of Cement Mortar," *International Journal of Civil and Structural Engeering,* vol. 3, no. 3, pp. 621-628, 2013.

[11] A. Mathur and M. Mahim, "An Experimental Study on the Effect of Replacement of Natural Sand with Manufacture Sand," *International Journal of Engineering Research & Technology (IJERT),* vol. 6, no. 11, 2018.

[12] S. Kumars and R. S. Kotian, "M-SAND, An Alternative To The River Sand In Construction Technology," *International Journal of Scientific & Engineering Research,* vol. 9, no. 4, pp. 98-102, April 2018.

[13] Sudha, K. D. Krishnan, P. T. Ravichandran and P. K. Rajkumar, "Strength Characteristics of High Strength Concrete using M-Sand," *Indian Journal of Science and Technology,* vol. 9, no. 41, November 2016.

[14] Vijaya and S. S. Selvan, "Experimental Investigation on the Strength and Durability Properties of Concrete Using Manufacturing Sand," *International Journal of Applied Engineering Research,* vol. 10, no. 68, pp. 109-114, 2015.

[15] S. George, J. John, P. N. Magudeswaran and R. Thenmozhi, "Replacement of River Sand Using Manufactured Sand and Quarry Dust in Cement Concrete," *Nature Environment and Pollution Technology,* vol. 7, no. 3, pp. 475-478, 2008.

[16] M. M. Vijay, M. S. Satheeshkumar, M. N. M. Selvakumar and M. N. Guruvugnesh, "Effect of Partial Replacement of Fine Aggregate with Artificial Sand," *International Journal of Engineering Research & Technology (IJERT),* vol. 6, no. 10, 2018.

[17] S. M. Basha, M. S. K. Reddy and S. B. F. Basha, "Investigation on Strength and Durability of Concrete Replacing Fine Aggregate by Quarry Dust," *International Journal of Research and Analysis Review (IJRAR),* vol. 5, no. 04, pp. 1065-1071, December 2018.

[18] S. S. Shinde, S. R. Kadam and A. A. Waychal, "Experimental Study of Compressive Strength of Concrete with Partial Replacement of Natural Sand with Manufacturing Sand," *International Research Journal of Engineering and Technology (IRJET),* vol. 03, no. 12, pp. 719-722, December 2016.

[19] P. N. Prashanth and N. S. S. Reddy, "Performance of High Strength Concrete - Partially Replacing Fine Aggregate with Manufactured Sand," *International Research Journal of Engineering and Technology (IRJET),* vol. 04, no. 11, pp. 2079-2087, November 2017.

[20] T. Shanmugapriya, K. S. Raja and C. Balaji, "Strength and Durability Properties of High Performence Concrete with Manufactured sand," *ARPN Journal of Engineering and Applied Science,* vol. 11, no. 09, pp. 6036-6045, May 2016.

[21] Vijaya and S. S. Selvan, "Comparative Study on the Strength and Durability Properties of Concrete with Manufactured Sand," *Indian Journal of Science and Technology,* vol. 8, no. 36, December 2015.

[22] B. Vijaya, S. Senthil Selvan, T. Felix Kala and R. Annadurai, "Experimental Investigation on the Strength Characteristics of Concrete Using Manufactured Sand," *International Journal for Innovative research in Science & Technology,* vol. 1, no. 8, pp. 174-178, January 2015.

[23] H. R. Raut and A. B. Ugale, "Effect of Artificial Sand on Compressive Strength and Workability of Concrete," *International Journal of Engineering Research,* vol. 5, no. Special 3, pp. 673-674, 27-28 Feb 2016.

[24] K. S. Prakash and C. H. Rao, "Study on Compressive Strength of Quarry Dust as fine Aggregate in Concrete," *Hindawi Publishing Corporation Advances in Civil Enguneering,* vol. 2016, p. 5, 2016.

[25] P. A. Jadhav and D. K. Kulkarni, "An Experimental Investigation On The Propertied of Concrete Containing Manufacturing Sand," *International Journal of Advanced Engineering Technology,* vol. III, no. II, pp. 101-104, April-June 2012.

[26] R. P. Mogre and D. K. Parbat, "Optimum Replacement of Natural Sand With Artificial Sand in Concrete," *International Journal of Civil, Structure, Environment and Infrastructure Engineering Research and Development (IJCSEIERD),* vol. 3, no. 5, pp. 91-98, December 2013.

[27] A. Kulkarni, K. Bhutada and A. Shelorkar, "Determination of Mechanical Strength For High Grade Concrete By Partial Replacement of Aritificial Sand," *Internatioanl Journal of Innovative Research in Science, Engineering and Technology,* vol. 3, no. 5, pp. 12380-12386, May 2014.

[28] Balamurugan and D. P. Perumal, "Use of Quarry Dust to Replace Sand in Concrete- An Experimental Study," *Internatioanl Journal of Scientific and Research Publications,* vol. 3, no. 12, December 2013.

[29] V. Awasare, R. Mahatme, A. Patel, V. Thorwat, P. Patil and A. Zambre, "An Experimental Study on Effect of Replacing Natural sand by Artificial Sand on Properties of Concrete," *International Research Journal of Enginnering and Technology (IRJET),* vol. 06, no. 03, pp. 6540-6546, May 2019.

[30] T. D. Kumar and G. Kalyan, "An Experimental Study on Strength Parameters of Concrete With Replacement of Fine Aggregate By Robo Sand," *International Journal of Engiuneering Sciences & Research Technology,* pp. 241-255, March 2018.

IS CODE:

[1] IS 8112:1989 is used for knowing the properties of Portland cement.

[2] IS 383:1970 is used to check the gradation and zone of the fine aggregate.

[3] IS 10262:2009 is used to carry out mix design calculations.

[4] IS 456:2000 is used to check the compressive and tensile strength and also as a part of mix design.

[5] IS: 4031 (Part 6) – 1988 physical test for cement.

[6] IS 2386-2 (1963): Methods of test for aggregates for concrete.